National Aeronautics and
Space Administration

Langley Research Center
Hampton, VA 23681-2199

Educational Product	
Educators	**Grades 3-5**

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The NASA SCI Files™
The Case of the Wacky Water Cycle

A Lesson Guide with Activities in Mathematics, Science, and Technology

Please Note: Our name has changed! The NASA "Why" Files™ is now the NASA SCIence Files™ and is also known as the NASA SCI Files™.

http://scifiles.larc.nasa.gov

The Case of the Wacky Water Cycle lesson guide is available in electronic format through NASA Spacelink - one of NASA's electronic resources specifically developed for the educational community. This publication and other educational products may be accessed at the following address: **http://spacelink.nasa.gov/products**

A PDF version of the lesson guide for NASA SCI Files™ can be found at the NASA SCI Files™ web site: **http://scifiles.larc.nasa.gov**

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www.swe.org

www.buschgardens.com

www.cnu.edu

www.epals.com

www.nec.com

www.sbo.hampton.k12.va.us

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For additional information about the NASA SCI Files™, contact Shannon Ricles at (757) 864-5044 or **s.s.ricles@larc.nasa.gov**.

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Registered users of the NASA SCI Files™ may request a Society of Women Engineers (SWE) classroom mentor. For more information or to request a mentor, e-mail **kimlien.vu@swe.org**

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Program Overview

The tree house detectives are eager to earn money to help Kathryn sponsor her soccer team on a white-water rafting trip. They plan to have a car wash to raise money. However, their efforts soon dry up as KSNN™ announces that the water level in the reservoir has dropped drastically and water restrictions are in force. The tree house detectives are disappointed but understand the importance of following the restrictions. They are a little confused, however, because they have been unaware of any drought-like conditions that could have caused the lower water level in the reservoir.

One group of tree house detectives decides to head to NASA Langley Research Center in Hampton, Virginia where they speak with Dr. David Hamilton to learn about the water cycle. Another group of detectives heads to Luray Caverns in Virginia to speak with Dr. D to learn more about water and where it is found on Earth. They are surprised to learn that a lot of the Earth's freshwater is located underground, which leads them to Ms. Hamilton, a hydrologist with the United States Geologic Survey (USGS), who explains facts about groundwater.

As the tree house detectives continue their investigation into the problem, they decide that if a lot of freshwater is underground, they need to learn more about how water gets into the ground. They contact a NASA SCI Files™ Kids' Club that is conducting an experiment on the permeability of soil types with help from their Society of Women Engineers (SWE) mentors. After learning more about groundwater, they find out that the groundwater levels will rise when it rains. They set off to check out the weather forecast and contact Dr. James Hoke of the National Oceanic and Atmospheric Administration (NOAA), who helps them understand how weather forecasts are made. After learning that weather forecasts today are pretty accurate, they become discouraged because there is no rain predicted for the next three days. The car wash is in four days! Not sure whether they are experiencing a drought or if something has happened to change the climate, the detectives contact Corinne, one of the NASA SCI Files™ Kids' Club members, to have her meet Dr. D at the Petrified Forest in Arizona to learn more about climates.

After learning that climates change very slowly over time, the detectives rule out the possibility of a climate change causing the drop in the water level. However, Dr. D mentioned that some climatic events could disrupt the normal climate patterns, so they decide to learn more from Dr. David Adamec at NASA Goddard Space Flight Center in Greenbelt, Maryland. Dr. Adamec explains the phenomenon of the El Niño and La Niña weather patterns and tells how they affect the weather across the United States. Getting more discouraged, the detectives decide that they need to find an alternate source of water. Jacob hopes to find a source of water just under their feet with his divining rod. On the more practical end, Corinne agrees to meet Dr. D again at the Hoover Dam in Henderson, Arizona. Dr. D explains watersheds and the purpose of dams. Realizing that there is no way they can build a dam in the next two days and that they have no expectations the divining rod will work, they decide to find a different alternate source of water.

With a whole ocean of water just a few miles away, the detectives decide to learn more about how to turn saltwater into freshwater. They dial up Mr. Ken Herd in Tampa, Florida at the Tampa Bay Desalination Plant. The tree house detectives now become truly discouraged. Desalination is very expensive, there is no rain in the forecast, the climate has not changed, and they are running out of ideas.

They decide that if the restrictions are going to continue, they had better learn more about water conservation. They are off to enjoy a hot summer day and visit Mr. Brian Nadeau at Busch Garden's Water Country USA in Williamsburg, Virginia. Next stop is the Hampton Roads Water Efficiency Team in Hampton, Virginia, where they learn more about water conservation from Ms. Hillegass. They are also surprised to learn that Ms. Hillegass questions the need for the current water restrictions. After one more trip to Dr. D, they are confident that the water will flow soon.

National Science Standards (Grades K – 4)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Unifying Concepts and Processes				
Systems, orders, and organization	✖	✖	✖	✖
Evidence, models, and explanations	✖	✖	✖	✖
Change, constancy, and measurement	✖	✖	✖	
Evolution and equilibrium	✖	✖		
Science as Inquiry (A)				
Abilities necessary to do scientific inquiry	✖	✖	✖	✖
Understandings about scientific inquiry	✖	✖	✖	✖
Physical Science (B)				
Properties of objects and materials	✖			
Life Science (C)				
Organisms and their environments			✖	✖
Earth and Space Science (D)				
Properties of Earth materials	✖	✖		
Changes in Earth and sky	✖	✖	✖	✖
Science in Personal and Social Perspective (F)				
Type of resources	✖	✖	✖	✖
Changes in environment	✖	✖	✖	✖
Science and technology in local challenges		✖	✖	✖
History and Nature of Science (G)				
Science as a human endeavor	✖	✖	✖	✖

National Science Standards (Grades 5 – 8)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Unifying Concepts and Processes				
Systems, order, and organization	✖	✖	✖	✖
Evidence, models, and explanations	✖	✖	✖	✖
Change, constancy, and measurement	✖	✖	✖	
Evolution and equilibrium	✖	✖		
Science as Inquiry (Content Standard A)				
Abilities necessary to do scientific inquiry	✖	✖	✖	✖
Understandings about scientific inquiry	✖	✖	✖	✖
Physical Science (B)				
Properties and changes of properties in matter	✖	✖	✖	
Transfer of energy	✖	✖		
Earth and Space Science (D)				
Structure of the Earth system	✖	✖	✖	✖
Earth's history		✖	✖	✖
Earth in the solar system	✖	✖	✖	✖
Science and Technology (Content Standard E)				
Abilities of technological design	✖	✖	✖	✖
Understanding science and technology	✖	✖	✖	✖
Science in Personal and Social Perspectives (Content Standard F)				
Science and technology in society	✖	✖	✖	✖
History and Nature of Science (Content Standard G)				
Science as a human endeavor	✖	✖	✖	✖
Nature of science	✖	✖	✖	✖
History of science		✖		

National Mathematics Standards (Grades 3 – 5)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Number and Operations				
Understand numbers, ways of representing numbers, relationships among numbers, and number systems.	✖	✖		✖
Understand meanings of operations and how they relate to one another.	✖	✖		✖
Compute fluently and make reasonable estimates.	✖	✖		✖
Algebra				
Use mathematical models to represent and understand quantitative relationships.			✖	
Geometry				
Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.	✖			
Use visualization, spatial reasoning, and geometric modeling to solve problems.	✖			
Measurement				
Understand measurable attributes of objects and the units, systems, and processes of measurement.	✖	✖	✖	
Apply appropriate techniques, tools, and formulas to determine measurements.	✖	✖	✖	✖
Data Analysis and Probability				
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.	✖	✖	✖	
Select and use appropriate statistical methods to analyze data.		✖	✖	
Develop and evaluate inferences and predictions that are based on data.	✖	✖	✖	✖
Understand and apply basic concepts of probability.	✖	✖	✖	
Problem Solving				
Build new mathematical knowledge through problem solving.	✖	✖	✖	✖
Solve problems that arise in mathematics and in other contexts.	✖	✖		
Apply and adapt a variety of appropriate strategies to solve problems.		✖		
Communication				
Organize and consolidate mathematical thinking through communication.	✖	✖	✖	✖
Communicate mathematical thinking coherently and clearly to peers, teachers, and others.	✖	✖	✖	✖
Representation				
Create and use representation to organize, record, and communicate mathematical ideas.	✖	✖		

International Technology Education Association (ITEA Standards for Technology Literacy, Grades 3 – 5)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Nature of Technology				
Standard 1: Students will develop an understanding of the characteristics and scope of technology.	✖	✖	✖	✖
Standard 2: Students will develop an understanding of the core concepts of technology.			✖	✖
Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.		✖	✖	
Technology and Society				
Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.			✖	
Standard 5: Students will develop an understanding of the effects of technology on the environment.	✖	✖	✖	✖
Standard 6: Students will develop an understanding of the role of society in the development and use of technology.		✖	✖	
Standard 7: Students will develop an understanding of the influence of technology on history.		✖	✖	
Design				
Standard 8: Students will develop an understanding of the attributes of design.	✖	✖	✖	✖
Standard 10: Students will develop an understanding of the role of troubleshooting, research, and development, invention and innovation, and experimentation in problem solving.	✖	✖	✖	✖
Abilities for a Technological World				
Standard 11: Students will develop the abilities to apply the design process.	✖	✖	✖	✖
Standard 12: Students will develop abilities to use and maintain technological products and systems.	✖	✖	✖	✖
The Designed World				
Standard 17: Students will develop an understanding of and be able to select and use information and communication technologies.	✖	✖	✖	✖

National Technology Standards (ISTE National Educational Technology Standards, Grades 3 – 5)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Basic Operations and Concepts				
Use keyboards and other common input and output devices efficiently and effectively.	✖	✖	✖	✖
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	✖	✖	✖	✖
Social, Ethical, and Human Issues				
Discuss common uses of technology in daily life and their advantages.		✖	✖	
Technology Productivity Tools				
Use general purpose productivity tools and peripherals to support personal productivity, remediate skill deficits, and facilitate learning throughout the curriculum.	✖	✖	✖	✖
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	✖	✖	✖	✖
Technology Communication Tools				
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	✖	✖	✖	✖
Use telecommunication efficiently and effectively to access remote information, communicate with others in support of direct and independent learning, and pursue personal interests.	✖	✖	✖	✖
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	✖	✖	✖	✖
Technology Research Tools				
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	✖	✖	✖	✖
Use technology resources for problem solving, self-directed learning, and extended learning activities.	✖	✖	✖	✖
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.	✖	✖	✖	✖
Technology Problem-Solving and Decision-Making Tools				
Use technology resources for problem solving, self-directed learning, and extended learning activities.	✖	✖	✖	✖
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.	✖	✖	✖	✖
Evaluate the accuracy, relevance, appropriateness, comprehensiveness, and bias of electronic information sources.	✖	✖	✖	✖

National Geography Standards, Grades 3 - 5

Standard	Segment 1	Segment 2	Segment 3	Segment 4
The World in Spatial Terms				
Standard 1: How to use maps and other graphic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.			✖	
Places and Regions				
Standard 4: The physical and human characteristics of places.	✖	✖	✖	
Standard 5: People create regions to interpret Earth's complexity.		✖		
Physical Systems				
Standard 7: The physical process that shapes the patterns of Earth's surface.	✖	✖	✖	
Standard 8: The characteristics and spatial distribution of ecosystems on Earth's surface.	✖	✖	✖	
Environment and Society				
Standard 14: How human actions modify the physical environment.	✖	✖	✖	✖
Standard 15: How physical systems affect human systems.		✖		
Standard 16: The changes that occur in the meaning, use, distribution, and importance of resources.	✖	✖	✖	
The Uses of Geography				
Standard 17: How to apply geography to interpret the past.		✖		

The NASA SCI Files™
The Case of the
Wacky Water Cycle

Segment 1

Just as the tree house detectives begin planning a car wash to raise money for a white-water rafting trip, they hear a report from KSNN™ suggesting that water restrictions will begin at once! Unsure if the report is accurate and not knowing much about water levels, they decide to do some investigating on their own. As the detectives begin their research, they stop by to see Dr. D, who just happens to be at Luray Caverns conducting research on water in caves. Dr. D amazes them with the idea that the total amount of water on the Earth is the same today as it was millions of years ago. Meanwhile, Catherine and Tony stop by to see Mr. Hamilton, an aerospace technologist at NASA Langley Research Center to learn more about the water cycle. New clues lead them to a hydrologist at the United States Geological Survey (USGS) to gather some important information about aquifers and how they are used.

Objectives

The student will

- demonstrate how water molecules move through the water cycle.
- identify the processes of evaporation, condensation, and precipitation as part of the water cycle.
- learn how caves are formed.
- understand that water is a limited resource.
- identify where water can be found on the Earth.
- observe how water moves through the ground.
- construct a model of an aquifer.

Vocabulary

acid – a corrosive solution which is able to break down or destroy something by chemical action

aquifer – an underground bed of saturated rock that holds large quantities of water

condensation – the process by which a gas becomes a liquid

drought – an extended period of time with little or no precipitation

evaporation – the process by which a liquid becomes a gas

groundwater – water found in spaces between soil particles underground

hydrologist – scientist who studies water

meteorologist – scientist who studies weather and climate patterns

precipitation – water falling in a liquid or solid state from the atmosphere to Earth as rain, sleet, snow, or hail

recharge (of groundwater) – groundwater supplies are filled again or replenished as water enters the saturation zone by actions such as rain or melting snow

reservoir – a large tank or natural or artificial lake used for collecting and storing water for human use

saturated zone – the portion below the Earth's surface that is soaked with water

stalactite – an icicle-like deposit of calcite hanging from the ceiling of a cave

stalagmite – a pillar in a limestone cave that is slowly built upward from the floor as a deposit from groundwater seeping through and dripping from the cave's roof

surface water – water above the surface of the land, including lakes, rivers, streams, ponds, floodwater, and runoff

water cycle – the paths water takes as a liquid, solid, or gas as it moves throughout Earth's systems; also known as the hydrological cycle

water restrictions – limits put on public and private use of water

water table – the top of an unconfined aquifer that indicates the level below which soil and rock are saturated with water

water vapor – the state of water in which individual molecules are highly energized and move about freely; water as a gas

well – a hole that is drilled or dug for the purpose of getting water from the ground

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Prior to viewing Segment 1 of *The Case of the Wacky Water Cycle*, read the program overview (p. 5) to the students. List and discuss questions and preconceptions that students may have about the water cycle, how much usable water can be found on Earth, or how water in an aquifer is measured.
2. Record a list of issues and questions that the students want answered in the program. Determine why it is important to define the problem before beginning. From this list, guide students to create a class or team list of three issues and four questions that will help them better understand the problem. The following tools are available in the educator area. To locate them, click on the educator's menu bar on the home page, then click on "Tools" and then "Instructional Tools." You will find them listed under the "Problem-Based Learning" tab.

   Problem Board—Printable form to create student or class K-W-L chart

   Guiding Questions for Problem Solving—Questions for students to use while conducting research

   Problem Log and Rubric—Printable log for students with the stages of the problem-solving process

   Brainstorming Map—Graphic representation of key concepts and their relationships

   The Scientific Method Flowchart—Chart that describes the scientific method process
3. Focus Questions—Questions at the beginning of each segment that help students focus on a reason for viewing. These questions can be printed ahead of time from the educator's area of the web site in the "Activities/Worksheet" section under "Worksheets" for the current episode. Students should copy these questions into their science journals prior to viewing the program. Encourage students to take notes while viewing the program to answer the questions. An icon will appear when the answer is near.
4. What's Up? Questions—Questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. These questions can be printed from the educator's area of the web site in the "Activities/Worksheet" section under "Worksheets" for the current episode.

View Segment 1 of the Video

For optimal educational benefit, view *The Case of the Wacky Water Cycle* in 15-minute segments and not in its entirety. If you are watching a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students reflect on the "What's Up?" questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Students should work in groups or as a class to discuss and list what they know about the water cycle and how it functions as a system on Earth. Have the students conduct research about the water cycle and brainstorm what might be causing the significant decline in the water table. As a class, reach a consensus on what additional information is needed. Have the students conduct independent research or provide students with the information needed.
4. Have the students complete Action Plans, which can be printed from the educator area or the tree house's "Problem Board" area in the "Problem-Solving Tools" section of the web site for the current online investigation. Students should then conduct independent or group research by using books and Internet sites noted in the "Research Rack" section of the "Problem Board" area in the tree house. Educators can also search for resources by topic, episode, and media type under the Educator's main menu option Resources.

5. Choose activities from the educator guide and web site to reinforce concepts discussed in the segment. The variety of activities is designed to enrich and enhance your curriculum. Activities may also be used to help students "solve" the problem along with the tree house detectives.
6. Have the students work individually, in pairs, or in small groups on the Problem-Based Learning (PBL) activity on the NASA SCI Files™ web site. To locate the PBL activity, click on the tree house and then the "Problem Board." Choose the "2003–2004 Season" and click on The Land of Fill.
   - To begin the PBL activity, read the scenario (Here's the Situation) to the students.
   - Read and discuss the various roles involved in the investigation.
   - Print the criteria for the investigation and distribute.
   - Have students begin their investigation by using the "Research Rack" and the "Problem-Solving Tools" located on the bottom menu bar for the PBL activity. The "Research Rack" is also located in the tree house.
7. Having students reflect in their journals what they have learned from this segment and from their own experimentation and research is one way to assess student progress. In the beginning, students may have difficulty reflecting. To help them, ask specific questions that are related to the concepts.
8. Have students complete a Reflection Journal, which can be found in the Problem-Solving Tools section of the online PBL investigation or in the Instructional Tools section of the Educator's area.
9. The NASA SCI Files™ web site provides educators with general and specific evaluation tools for cooperative learning, scientific investigation, and the problem-solving process.

Careers

hydrologist
meteorologist
geologist
aerospace technologist

Resources (additional resources located on web site)

Books

Hobbs, Will: *Downriver*. Bantam Doubleday, 1996, ISBN: 0440226732.

Hooper, Meredith: *The Drop in My Drink: The Story of Water on Our Planet*. Viking Penguin, 1998, ISBN: 0670876186.

Lesser, Carolyn: *Storm on the Desert*. Harcourt, 1997, ISBN: 0152721983.

Locker, Thomas: *Water Dance*. Voyager Books, Harcourt, Inc., 1997, ISBN: 0152163964.

London, Jonathan: *White Water*. Penguin Putnam, 2001, ISBN: 0670892866.

Petersen, P.J.: *White Water*. Random House Books, 1999, ISBN: 0440415527.

Polacco, Patricia: *Thundercake*. Putnam Publishing, 1990, ISBN: 0399222316.

Pratt-Serafini, Kristen: *Salamander Rain*. Dawn Publications, 2001, ISBN: 1584690186.

Rauzon, Mark J. and Bix, Cynthia: *Water, Water Everywhere*. Sierra Club Books for Children, 1995, ISBN: 0871563835.

Robinson, Sandra: *The Rainstick: A Fable*. Globe Pequot Press, 1994, ISBN: 1560442840.

Taylor, Barbara: *Earth Explained: A Beginner's Guide to Our Planet*. Henry Holt and Company, 1997, ISBN: 0805048731.

Wick, Walter: *A Drop of Water: A Book of Science and Wonder*. Scholastic, Inc., 1997, ISBN: 0590221973.

Web Sites

USGS—Water Science for Schools
http://wwwga.usgs.gov/edu/wugw.html
This comprehensive water site sponsored by the USGS includes information about the Earth's water, aquifers, rainfall, and groundwater, as well as the chemical properties of water and common water measurements. Special topics include acid rain, water shortages, and why the ocean is salty. An interactive quiz section allows students to test their knowledge.

BrainPop
http://brainpop.com/science
Pick an animated movie that explains the water cycle, play a game, or participate in an experiment with Bob, the Rat. The site also contains dozens of additional science and history topics. Users may register to score points and keep track of activities they have done.

Ozark Cave Formation and Geology
http://www.nps.gov/ozar/skindeep.htm
This online teachers' guide developed by the National Park Service at Ozark National Scenic Riverways includes information on the geology and biology of caves, as well as several hands-on activities to help students understand cave formation.

The Water Cycle Starring H2O
http://www.nwf.org/nationalwildlifeweek/games/waterc yc_swf.html
Learn about the parts of the water cycle in this animated story with sound.

Kids-Only Game Time
http://kids.earth.nasa.gov/games
Students will enjoy playing these interactive games on-line that will help them understand Earth science concepts such as the water cycle, plate tectonics, and the data NASA collects about the Earth. Choose from eight different puzzles, quizzes, or games to test your knowledge.

Science Court
http://www.tomsnyder.com/classroom/scicourt/water cycle.html
Investigate the water cycle with Judge Stone and the Science Court as you determine whether you can find water in the air. Check your findings.

Activities and Worksheets

Around and Around It Goes

Purpose

To understand how water molecules move through the water cycle

Materials

Water Cycle Score Card (p. 20)
8 cups
pencil
scenario strips

Background

Water covers about 75 percent of the Earth and is constantly moving. Energy from the Sun, which allows evaporation, and gravity are the driving forces that power the water cycle. The movement is greatly influenced by the contour of the land and geologic features such as mountains, valleys, and hills. While water does circulate from one state to another in the water cycle, the path it can take is variable.

Teacher Prep

Make a sign for each station that includes the station name and number. Cut the scenario strips apart and place them in a cup at each station. Before playing the game, discuss cycles with the students. Divide the class into eight groups and send each group to a station to begin. Say the word "CYCLE" when you are ready for students to move to the next station. Repeat until most of the students have cycled through the Cloud station a couple of times.

Procedure

1. You are a water molecule. To find out about your journey through the water cycle, remove a strip from the cup at your station.
2. Read the strip.
3. Write the information on your Water Cycle Score Card.
4. Put the strip back in the cup.
5. When you hear the word "CYCLE", move to the next station, as directed by the strip. You may not be with the same group any longer.
6. Repeat steps 1–5 until you are told to stop. You may go to the same station more than once; be sure to always follow the directions on the strip you removed from the cup.
7. After you finish playing the game, go back to your seat and look at your Water Cycle Score Card.
8. Make a diagram of the path you took. For example, your journey might have taken you from the Cloud • Mountain • Cloud • Lake • Animal • Lake.

Conclusion

1. Even though each water molecule took a different path, was anything similar about the journeys you took?
2. Classify each part of your journey as evaporation, condensation, or precipitation.
3. Can you think of other parts of the water cycle that were not included in the game?
4. What makes water move through the water cycle?
5. What would happen if all of Earth's water stayed in the oceans?
6. Why did the tree house detectives need to understand the water cycle to help solve their problem?

Extension

1. Write a story about the journey you took or illustrate the journey by making a cartoon or comic book.
2. Choose two different locations on a map. Write a story about how you, as a water droplet, got from one place on the map to the other. Be creative.

Water Cycle Score Card

Example: *Cloud*	*Falls as rain*	*Mountain*	*Precipitation*
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

On the back, draw a diagram of your entire journey.

STATION PAGE

STATION STOPS

STATION 1 – CLOUD
You fall as rain onto a mountain. Go to the mountain.
You fall as snow onto a mountain. Go to the mountain.
You fall as rain onto a stream. Go to the stream.
You fall as rain on a farmer's field. Go to the plant.
You fall as rain onto a parking lot. Go to the stream.
You fall as snow onto a lake. Go to the lake.

STATION 2 – MOUNTAIN
You evaporate into the air. Go to the cloud.
You soak into the ground and become part of the groundwater. Go to the groundwater.
You soak into the ground and are absorbed by a plant's roots. Go to the plant.
You roll downhill and become part of a lake. Go to the lake.
You become frozen and stay there. Stay at the mountain.
You drip off the rocks and join other drops in a small stream. Go to the stream.

STATION 3 – LAKE
An animal drinks you. Go to the animal.
You flow into a stream. Go to the stream.
You remain in the lake. Stay in the lake.
You are absorbed by the leaves of a plant. Go to the plant.
You evaporate into the air. Go to the cloud.

STATION 4 – STREAM
You evaporate into the air. Go to the cloud.
You continue rolling across the land and become part of the ocean. Go to the ocean.
You are pulled down into the soil on the bank. Go to the groundwater.
An animal drinks you. Go to the animal.
You flow into a lake. Go to the lake.
While flowing down the mountain, you freeze and stay there. Go to the mountain.

STATION 5 – GROUNDWATER
You become part of an underground river that flows to the ocean. Go to the ocean.
You are absorbed by the roots of a plant. Go to the plant.
You are pumped out of a well for a person to drink. Go to the person.
You are pumped out of a well for a person to wash dishes. Go to the stream.
You are pumped out of a well for a farmer to irrigate his field. Go to the plant.
You become part of an underground river that flows to the ocean. Go to the ocean.
You stay in the aquifer. Stay at the groundwater.

STATION PAGE

STATION 6 – ANIMAL
You are breathed out of a person's lungs into the air as water vapor. Go to the cloud.
A person uses you for brushing his or her teeth. Go to the stream.
After using you to process food, the animal urinates, and you end up on the ground. Go to the mountain.
You are excreted as sweat and evaporate into the air. Go to the cloud.
A person takes a drink of water and spits you out onto the ground. You seep into the soil and become part of the groundwater. Go to the groundwater.

STATION 7 – PLANT
The plant transpires you through its leaves. You evaporate into the air. Go to the cloud.
The plant stores you in its fruit and you are eaten. Go to the animal.
The plant uses you to grow. Stay at the plant.
The plant transpires you through its leaves. You evaporate into the air. Go to the cloud.
The plant stores you in a root and you are eaten. Go to the animal.

STATION 8 – OCEAN
You are one of the many water molecules in the ocean and you stay there. Stay at the ocean.
You evaporate into the air. Go to the cloud.
A kelp plant takes you in, releases you through its leaf, and transpires you into the air. Go to the cloud.
You are swallowed by a fish. Go to the animal.

A Cycling We Will Go

Purpose

- To identify the processes of evaporation, condensation, and precipitation as part of the water cycle
- To measure the volume of liquid added to the water cycle and estimate the amount of liquid that evaporates after a period of time

Materials

large size plastic, zippered storage bags
bathroom size clear plastic cups (3.5 oz)
masking tape
beaker or graduated cylinder
water
marker
tape

Procedure

1. Place 60 mL of water in a cup and use a marker to mark the water line.
2. Put the cup in the bottom corner of the bag so the bag is tilted like a diamond. This step is important so the sides will slant down from the top and allow the water drops to slide down and collect in the bottom of the bag. See diagram 1.
3. Tape the cup to the inside of the bag to prevent spilling.
4. Close the bag tightly and carefully tape it in a warm, sunny place.
5. In your science journal, predict what will happen to the water in the cup.
6. Observe the bag several times a day for four days.
7. Record and illustrate your observations.
8. On day 5, open your bag and carefully remove the cup.
9. Estimate how much water is in the cup and in the bag.
10. To measure the amount of water remaining in the cup, carefully pour the water from the cup into the graduated cylinder. Read and record.
11. Add the water that is in the bag to the graduated cylinder by carefully pouring it from one corner of the bag.
12. Read and record the total amount of water from the bag and cup. How much water was in the bag?

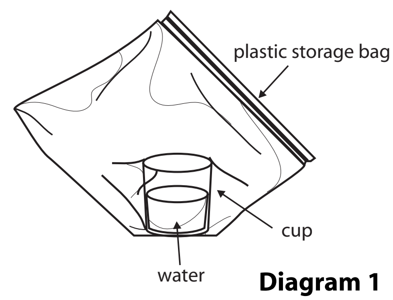


Diagram 1

Conclusion

1. Use this experiment to define the three major processes in the water cycle.
2. What happened to the water that was not in the cup or in the bag?
3. Explain what would happen if you left the water cycle bag in a warm place for a month?

Extension

1. Perform the same experiment again by using another liquid such as saltwater, soda, or rubbing alcohol. How did your results change?
2. Change other variables of the experiment such as the amount of light, temperature, color of the bag, amount of water, or size of the bag. How did these factors affect your findings?
3. Add a few drops of food coloring to represent contaminants. Observe and record what happens to the contaminants as they become part of the water cycle.
4. Based on the mini-water cycle, design a self-watering plant container.

Cave-Cicles

Purpose

To understand how limestone formations are created inside a cave

Background

When water mixes with carbon dioxide in the air, it forms a weak acid. This carbonic acid eventually ends up in groundwater. One type of rock that is easily dissolved by this acid is limestone. As the water dissolves the limestone, the calcite in the limestone mixes with the water. As this mixture drips and evaporates, it creates calcite crystals in two formations:

- stalactites, which hang tight from the top or ceiling (Think of the "c" for ceiling.)
- stalagmites, which grow from the floor of the cave and might reach the ceiling some day (Think of "g" for ground.)

It may take hundreds and even millions of years for these formations to grow even a few centimeters.

Materials

2 plastic cups
250 mL Epsom salts
250 mL warm water
60-cm cotton or wool string
2 nails
spoon
cardboard (about 30 cm square)
science journal

Procedure

1. Stir Epsom salts into the warm water until no more will dissolve.
2. Pour the warm water equally into the two plastic cups.
3. Place the string in one cup to soak for three minutes.
4. Place the cardboard in an area where it will not be disturbed for several days.
5. Remove the string from the cup and tie a nail to each end of the string.
6. Place the two cups at opposite ends of the cardboard.
7. Put one nail into each cup.
8. Adjust the distance of the two cups from each other until the string is slightly taut, leaving a dip in the middle of the string. See diagram 1.
9. Observe and record your observations daily in your science journal.

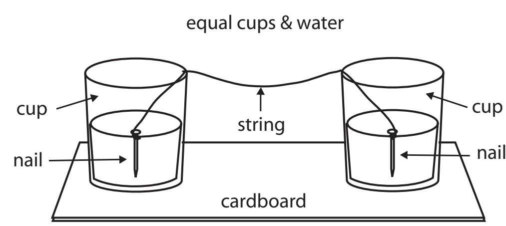


Diagram 1

Conclusion

1. What formed on the string and how?
2. How are these "cave-cicles" like the formations found in a real cave? How are they different?

Extension

With the help of an adult, find a recipe for rock candy and make it. Observe and illustrate the crystals that formed.

Caving Caverns

Materials

modeling clay (do not use Play Doh® or other water soluble clay)
3–6 sugar cubes
toothpick
table knife
clear plastic bowl
500 mL of water

Purpose

To demonstrate how water forms caves

Background

The two basic kinds of rocks found in most caves are limestone and sandstone. Limestone is a type of rock that is more easily dissolved by water. Sandstone is less water soluble but porous enough to allow water to pass through it.

Procedure

1. Flatten the clay into a pancake shape. The clay will be the outer layer of sandstone and shale for your cave.
2. Place the sugar cubes on the clay so that each cube touches at least one other cube and one cube touches the edge of the clay. The sugar cubes will be the limestone in your cave.
3. Wrap the clay around the sugar cubes, forming a ball. See diagram 1.
4. Poke holes in the clay with the toothpick to represent cracks and pores in the rocks. See diagram 2.
5. Put the water into the plastic bowl and set the clay ball into the water.
6. Observe and record your observations in your science journal.
7. Allow the clay to stay in the water for about 30 minutes.
8. Remove the clay ball from the water and set on a paper towel.
9. Carefully cut the clay ball in half.
10. Observe and record.

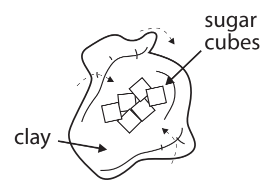


Diagram 1

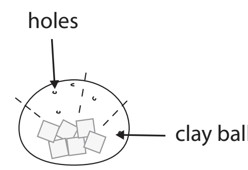


Diagram 2

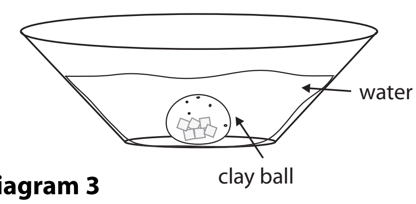


Diagram 3

Conclusion

1. What happened to the sugar cubes inside the clay ball?
2. How are the sugar cubes like the limestone found inside a cave? How are they different?
3. What effect does water have on limestone over many years?

Extension

1. Conduct research on caves that are open for public tours. Make a travel brochure that would encourage people to visit the cave. Be sure to tell about the features of the cave and where it is found.
2. Make a cave in a clear plastic container, such as a plastic glass. Stack sugar cubes in the bottom of the glass. Place a layer of clay over the top of the sugar cubes, pressing the clay tightly to the sides of the glass to form a cap. Using a toothpick, poke a few holes in the clay. Use a spray bottle or eyedropper to make it rain. Observe and record what happens as the water gets into the cracks and collects at the bottom.

Water, Water Everywhere

Materials

20 L water (5.3 gal)
large container (10-gal aquarium)
medium container (quart size)
3 small containers (pint size)
graduated cylinder
eyedropper
marker

Purpose

To understand that water is a limited resource and to demonstrate where usable water can be found on the Earth

Teacher Note:

This activity can be done as a class demonstration or in small groups.

Background

Although water covers about 75% of the Earth's surface, water is not as abundant as you may think. The amount of freshwater available on Earth for human use is only a small fraction (0.003%) of the total amount of water on the planet.

Procedure

1. Label the large container, "Earth's Water."
2. Label the medium container, "Freshwater," and the small containers, "Unavailable Water" and "Non-Usable Water."
3. Place 20 L of water in the "Earth's Water" container, which represents all the water in the world, including oceans, lakes, rivers, and groundwater.
4. Using a graduated cylinder, measure and pour 500 mL of water from "Earth's Water" into the "Freshwater" container, which represents the total amount of freshwater on the planet.
5. Create a second label, "Ocean Water," and place it over the "Earth's Water" label. The remaining 19.5 L in the large container now represents the water in the oceans, too salty for human beings to use. The oceans make up 97.5% of the total water volume on Earth.
6. Using a graduated cylinder, measure and pour 375 mL of water from the "Freshwater" container into the "Unavailable Water" container, which represents all the freshwater in glaciers, ice caps, the soil, and the atmosphere. This container is also unavailable for human use.
7. Using an eyedropper, remove 5 drops from the remaining "freshwater" container.
8. Pour the remaining water from the "Freshwater" container into the "Non-Usable Water" container, which represents all the water that is not readily available because it is very deep in the ground, in remote places, or polluted.
9. Place the five drops of water back into the "Freshwater" container, which represents the amount of clean water that is available for human use, only 0.003% of the 20 L you had in the beginning!

Conclusion

1. Where does our drinking water come from?
2. Why can't we use the majority of the water on the planet?
3. Is water a renewable resource?
4. Why is it important to manage water resources?

Extension

1. Develop a television commercial telling reasons why water is a limited resource.
2. Research a water habitat, such as the oceans, wetlands, or rivers. Find out what kind of animals and plants live there. Make a mural about these habitats.

Seepy Sandwich

Purpose

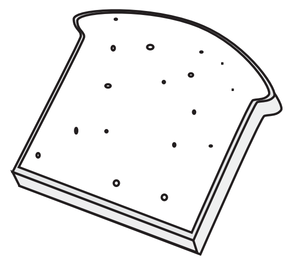
To demonstrate how water moves through the soil

Background

Groundwater is one of Earth's most valuable natural resources. More water is stored beneath the surface of the Earth than in rivers, streams, and lakes. The water stored in the pores, cracks, and openings of rock material found below the surface and between the particles of soil is groundwater. Scientists use the word aquifer to describe the layer of permeable rock that has connecting pores and transmits water freely (water-bearing rock). Gravity and the weight of the rocks and soil above the water level cause the water to seep downward toward the areas of least resistance.

Materials

food coloring
slice of bread
spray bottle of water
plastic tarps or outside area
science journal



Procedure

1. In an open outside area or over a tarp, hold a slice of bread (which represents the soil) vertically.
2. Add a drop of food coloring to the top crust edge of the bread.
3. Spray the water (rain) on the food coloring.
4. Allow drainage to seep through the crust into the bread.
5. Observe and record your observations in your science journal.
6. Illustrate your observations.

Conclusion

1. How did the water move through the soil (bread)?
2. What can you learn about groundwater from doing this experiment?
3. Why is groundwater an important resource?
4. What human factors might affect Earth's groundwater?

Extension

Place sand, gravel, and clay in separate clear containers. Look closely at each container with a hand-held magnifying lens. Pour water into each container. Observe the flow of the water through each material. Record your results.

Edible Aquifers

Purpose

To learn about the geology of an aquifer and how pumping can cause a decline in the water table

Materials

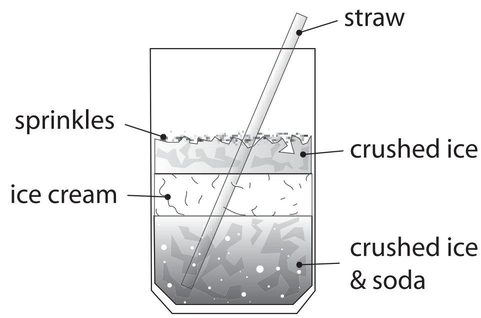
400 mL crushed ice
1 scoop vanilla ice cream
200 mL clear soda
30 mL colored cake decoration sprinkles
drinking straw
clear plastic cup
spoon
napkin
science journal

Background

Aquifers come in all shapes and sizes. Water quality and water quantity vary from aquifer to aquifer. The age of groundwater within an aquifer also varies. An unconfined surface aquifer might hold water that is only a few days, weeks, or months old. On the other hand, a deep aquifer that is covered by impervious layers may contain water that is hundreds or even thousands of years old. Some aquifers can yield millions of liters of water each day and maintain their level, while others are able to produce only small amounts of water.

Procedure

1. Fill a clear plastic cup 1/3 full of crushed ice to represent the permeable rock found underground.
2. Add enough soda (which represents water in your aquifer) to just cover the ice.
3. Add a layer of ice cream to serve as the layer over the water-filled aquifer.
4. Add more crushed ice on top of the confining layer.
5. Sprinkle cake decorations over the top to create the porous top layer of soil.
6. Using your straw, drill a well into the center of the aquifer.
7. Slowly begin to pump the well by sucking on the straw. Observe the decline in the water table.
8. Record your observations in your science journal.
9. Now try to recharge your aquifer by making it rain (slowly add more soda).
10. Observe and record your observations.
11. At the direction of your teacher, drain your aquifer dry and enjoy!



Conclusion

1. What purpose does a confining layer serve in an aquifer?
2. In what ways could an aquifer be recharged?
3. What might happen to an aquifer that was used but not recharged?

Extension

Poke holes in the ice cream layer and add 2–3 drops of food coloring to the top of the aquifer. Notice what happens as the contaminant seeps through the soil and the top layer. How does it affect the water in the aquifer? What happens to the contamination when water is pumped out through the well? Keep in mind that the same thing happens when contaminants are spilled on the Earth's surface.

Answer Key

Around and Around It Goes

1. Answers will vary but might include that they all visited the same places—just in a different order; there were more chances to evaporate than anything else.
2. Situations may not always be obvious. Encourage discussion.
3. Rivers, puddles, saltwater lakes and inland seas, reservoirs, glaciers, soil, and so on.
4. The water cycle is powered by the energy from the Sun that controls temperature and allows evaporation. Gravity is also a driving force in the water cycle. Geologic features, such as mountains, valleys, hills, and the general contour of the land play important roles in the movement of water through the water cycle as well. Finally, the chemical and physical properties of water itself enable the water to move through the hydrological cycle. Cohesion, surface tension, and the ability of water to exist in all three natural states play important roles in this dynamic cycle.
5. If all water remained in the oceans, life on Earth, as we know it, would cease to exist. All living things, both plant and animal, depend on water for survival. If no evaporation occurred, no precipitation would fall. Without rain, the plants would soon die. People would have no fresh drinking water, and the shape of the land would change dramatically without rivers, lakes, and streams.
6. The tree house detectives need to understand where our water comes from, that it is a limited resource, and that water moves in a dynamic cycle as a solid, a liquid, or a gas before they can determine what happened to the aquifer.

A Cycling We Will Go

1. Evaporation is the process by which liquid water is changed into water vapor, a gas. This process occurs through the application of heat energy during the water cycle. Condensation is the cooling of water vapor, or removal of heat energy, which allows it to become a liquid. (Dew is an example of condensation in the water cycle.) Precipitation occurs when water falls from the atmosphere to the Earth as rain, sleet, snow, or hail.
2. The water evaporated from the plastic bag into the air. The air inside the bag also contains vapor. Some students may have difficulty understanding how water could leave the plastic bag. A simple demonstration can help clarify that plastic is semipermeable. Put a couple of drops of vanilla extract inside a balloon. Blow up the balloon and tie the end. The balloon holds the air, but the smell of the vanilla will escape from the balloon. This process is known as osmosis.
3. Eventually, all the water would evaporate from the bag, leaving nothing behind. Conducting this same activity in a sealed glass jar, however, will allow you to see a long-term water cycle. It is this principle that makes bottle terrariums popular.

Cave-Cicles

1. The Epsom salts crystals were dissolved in the water, making a solution. As the water was absorbed into the cotton string, it traveled along the string to its lowest point. As the water evaporated into the air, the Epsom salt crystals were left behind.
2. In a cave, the limestone or dolomite is dissolved by groundwater that has mixed with carbon dioxide from the air to form a weak acid. This dissolved mineral drips into the cave. When the carbon dioxide is given off and the water begins to evaporate, the water no longer carries the minerals, and they are deposited in the shape of tiny crystals. These crystals are known as calcite, or cave onyx. Many different types of formations may occur, but the most recognizable are the stalactites, which hang from the ceiling, and stalagmites, which are formed when the supersaturated solution drips from the ceiling onto the floor of the cave before evaporating. This process is very slow, and it may take thousands and even millions of years for these formations to grow a few centimeters.

Answer Key (continued)

Caving Caverns

1. The sugar cubes inside the ball of clay dissolved as water made contact with the sugar.
2. Both the sugar and the limestone will dissolve in water. Water forms a solution with the sugar. A solution is a type of mixture in which one substance is evenly mixed with another. When water is added to the sugar, the taste of the water changes and the sugar becomes invisible, but the chemical makeup of each substance remains unchanged. Similarly, when water that has absorbed carbon dioxide passes through limestone (calcium carbonate), it dissolves the limestone. The water then carries away the solution of minerals, redepositing the calcite crystals in a variety of shapes as the water evaporates.
3. The process of forming caves in soluble rock is very slow. As a solution of water and carbon dioxide seeps through the cracks and crevices, it dissolves the soluble rock and forms cavities and channels as it moves downward and laterally. After thousands of years in the solution, underground rooms and chambers can be formed.

Water, Water, Everywhere

1. Our drinking water comes from the freshwater found on Earth. However, freshwater makes up only 3% of the Earth's water supply. Of that 3%, 77% is found in glacial ice caps, 22% in groundwater, and the remaining 1% in lakes, rivers, and the atmosphere. Surface water (lakes, rivers, reservoirs) and groundwater are the primary sources for drinking water, regardless of where you live.
2. We cannot use most of the water on Earth because 97% of it is salty ocean water. To make freshwater from saltwater, desalinization or distillation must occur, and it is a complicated process. With most of the freshwater on Earth locked into glaciers, ice caps, or as water vapor in the atmosphere, there is very little water that is accessible for human use.
3. No, water is not a renewable resource. However, water is a reusable resource because it can be used over and over, but the amount of water on the Earth is limited.
4. It is important that we protect both the quantity and the quality of our planet's water supply because all living things on Earth depend on it. Overuse and pollution can greatly diminish the available supply of potable, or usable water, and new water sources cannot be created, so we must learn to manage the water we already have on Earth.

Seepy Sandwich

1. As the water seeped through the bread, it branched out, moving in different directions in a general downward pattern.
2. Water seeps downward into the zone of saturation, an underground area in which every available space is filled with water. The size of the soil particle or grain determines the rate and path the water will take. The larger particle size provides more air space between particles through which water can flow. Watching the water seep through the bread makes it possible to see how the water branches out, seeking the available spaces to fill.
3. Much of our usable water on the planet (approximately 22%) is stored as groundwater. Almost half the people in the United States use groundwater as their primary water source.
4. Answers will vary but might include that overuse and pollution are two major human factors that affect groundwater.

Edible Aquifers

1. The confining layer in an aquifer is the impermeable layer of rock or clay that holds the water in the space above and below it. When the confining layer is the top layer, it forms a lid on the aquifer. The water inside the aquifer is then pressurized. If it is tapped by a well, it is forced upward and is known as an artesian well.
2. Aquifers are recharged by any water source that seeps into the ground. Precipitation, such as rain and snow, river runoff, irrigation, and discharge from households or industry are all viable recharge sources.
3. Continued and expanded use from an aquifer, especially shallow aquifers, will use up the contained water. If no recharge takes place, the aquifer could dry up or water levels could fall below a point where it is possible to reach them.

Answer Key (concluded)

On the Web

Spelunking

1. Spelunkers are aware of the fragile nature of a cave and that the formations before them took millions of years to appear as they do at that moment. Even the touch of a hand on a growing cave formation can cause permanent damage because the oils from human hands leave a film that prevents the new calcite crystals from adhering to the existing crystals.
2. Answers will vary.

Tree-mendous Transpiration

1. About 90% of the water that is taken from the soil by plant roots is reintroduced into the water cycle through the process of transpiration. Plants take water out of the soil and, in turn, use the water for growth, photosynthesis, and reproduction. The water is lost through the stomata, or openings on the leaves and evaporates into the air.
2. Water and minerals are drawn up through the roots of the plant, partly by a process called capillary action. Capillary action occurs when water molecules in a thin tube are more attracted to the surface they travel along than to each other or when they are pulled down by gravity. A plant contains tiny capillaries, or vessels, which allow the water to travel through the plant to the leaves. Transpiration "pull" also helps draw water through the vascular system. Transpiration pull is the pulling of water up into the leaf to replace the water that is lost through transpiration or used by photosynthesis.
3. All but a very small amount of the water that is lost through the leaves evaporates into the air. Some of the water that is lost through the leaves may drip onto the ground and be absorbed or used as drinking water by small insects, birds, or animals.

Sing a Song of Water

1. Answers will vary. Students' songs should explain components of the water cycle.

What Is Water Anyway?

1. Unlike most other matter, water is less dense in its solid state than in its liquid state, so ice floats instead of sinking. This property permits life to develop in polar and subpolar regions and allows life to continue living below the surface. If ice were denser than water, it would sink, and more ice would form on top of it. As a result, in the many areas where the temperature drops below the freezing point, life would be trapped in the ice.
2. The arrangement of the atoms in some molecules determines whether the molecule is polar or nonpolar. If the molecule has a positive electrical charge on one end and a negative charge on the other end, the molecule is called a polar molecule, meaning that it has electrical poles. The polarity of molecules determines whether or not they will form a solution with other molecules. The rule for determining whether a mixture becomes a solution can be explained this way: polar molecules will mix with each other to form solutions and nonpolar molecules will do the same, but a polar and nonpolar combination will not form a solution. Water is a polar molecule (with a positive and negative end), and oil is a nonpolar molecule. Thus, they will not form a solution.
3. A drop of water is small, but it is made of even smaller parts called molecules. Water molecules have bonds that hold them together. At the surface of the water, the molecules hold on to each other even more tightly because there are no molecules pulling on them from the air above. As the molecules on the surface stick together, they form an invisible "skin" called surface tension.
4. Soap molecules are attracted to both water and oil. One end of the soap molecule sticks to oil; the other end sticks to water. The soap breaks up the surface tension and keeps the oil drops mixed with the water.